REMARKS

Claims 1, 6, and 8-45 are in the application, with Claims 13-45 withdrawn from further consideration. Claim 1 is amended (1) to overcome a rejection under 35 USC 112, as discussed below, and (2) to incorporate the limitations of Claim 7 therein, which is canceled without prejudice.

Applicants' undersigned representative appreciates the opportunity to discuss the nature of the election of species in the above-identified patent application with the Examiner on November 4, 2004. At that time, a discussion was held regarding the status of Claims 12-15, which had previously been withdrawn as being directed to non-elected species. Yet, Claim 12 is indicated as now being allowable (if Applicants incorporate the limitations of Claims 7 and 9 into Claim 1), while Claims 13-15 remain withdrawn. Applicants' undersigned representative wishes to express his gratitude to the Examiner for explaining the reason why Claim 12 is allowable (close in structure to Claim 11) and the process for reviewing the remaining claims (Claims 13-15) once a generic claim is allowable.

The Examiner contends that newly submitted Claims 31-45 are directed to an invention that is independent or distinct from the invention originally claimed, and has required restriction under 35 USC 121 as follows:

Group I: Claims 31-45 (multiple electrode device); and

Group II: Claims 1-30 (bistable molecule and method of forming a device).

Due to having received an action on the merits, the Examiner has withdrawn Claims 31-45 from further consideration, on the basis that the Group II claims have been constructively elected by original presentation for prosecution on the merits. Applicants' silence on the Examiner's reasons for the restriction requirement should not be construed as agreement therewith. Further, Applicants preserve their right to file one or more divisional applications on the withdrawn claims.

Claims 1-12 are rejected under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. Claims 2-5 were canceled in Applicants' previous Amendment filed May 13, 2004, and Claim 7 is canceled herein.

The Examiner contends that the preamble of Claims 1-12 is misleading and confusing such that the intended preamble recites a "bistable molecule", but that the claims as recited pro-

ceed to recite a multiple electrode device having a bistable molecule as one of the components of the device.

The Examiner contends that the amendment to Claim 1 of May 28, 2004 [*sic: May 13, 2004*], fails to correct the problem.

Applicants respectfully disagree. However, in the interests of advancing the prosecution, the preamble of Claim 1 is amended to more clearly recite the features of the multiple electrode device and the relationship of the photopatternable bistable molecule to the device:

> 1. (currently amended) A photopatternable bistable molecule for a multiple electrode device, said multiple electrode device comprising at least one pair of electrodes that form at least one junction and at least one said bistable molecule connecting said pair of electrodes in said junction, said junction having a functional dimension in nanometers or micrometers, ~~wherein~~ said bistable molecule ~~includes~~ including at least one photosensitive functional group for photopatterning said bistable molecule, wherein said bistable molecule comprises a main chain and at least one pendant group and wherein at least one photosensitive functional group is attached either to said main chain or to said pendant group.

The material between "said multiple electrode device" and "said bistable molecule including" is directed to describing the multiple electrode device and the relationship of the bistable molecule thereto; this material is part of the preamble of the claim. The material following "said bistable molecule including" is directed to the bistable molecule itself and its chemical structure ("including at least one photosensitive functional group for photopatterning said bistable molecule, wherein said bistable molecule comprises a main chain and at least one pendant group and wherein at least one photosensitive functional group is attached either to said main chain or to said pendant group").

Applicants can find no limitation in the statute or in the regulations prohibiting the recitation of intended use of the bistable molecule, and respectfully request the Examiner to specifically cite his authority for maintaining his position that the recitation of intended use is prohibited. Otherwise, Applicants expect withdrawal of this rejection.

Reconsideration of the rejection of Claims 1, 6, and 8-12, as amended, under 35 USC 112, second paragraph, is respectfully requested.

Claims 1-8 are rejected under 35 USC 102(e) as being anticipated by Reed et al (U.S. Patent 6,320,200). It is noted that Claims 2-5 were canceled in Applicants' previous Amendment filed May 13, 2004. Claim 7 is canceled herein.

Reed et al disclose sub-nanoscale electronic devices and processes. Specifically, an integrated circuit structure is disclosed, including a plurality of transistors; a plurality of thin-film conductor interconnects, interconnected to form electronic circuits in a predetermined electrical configuration; and a plurality of pairs of contact pads, connected to the thin-film conductor interconnects, each adjacent pair of contact pads including a first pad of a first conductive material and a second pad of a second conductive material, and being electrically connected only by a conductive oligomer of a precisely determined number of units.

The Examiner cites this reference for its purported disclosure of bistable molecules in Col. 19, lines 41-67.

Applicants' Claim 1 is reproduced above. Claims 6-8 depend, directly or indirectly, from Claim 1.

The Examiner argues that Reed et al disclose photosensitive bistable molecules in Col. 19, lines 41-67, wherein "a photosensitive compounds display a bistable molecule having a photosensitive functional group". The Examiner directs Applicants' attention to the discussion of bacteriorhodopsin in lines 49-59, wherein a bistable molecule is photosensitive, thereby meeting the claimed limitation drawn to the claimed bistable molecule.

A search of the technical literature turns up several references to bacteriorhodopsin. It appears that the mechanism for switching involves a trans to cis photoisomerization around the thirteenth carbon atom to the fourteenth carbon double bond in the chromophore; see, e.g., "Bacteriorhodopsin Photocycle", http://www.cem.msu.edu/~chem181h/projects/96/memory/photocycle.html (1996). Clearly, such a trans to cis photoisomerization is not based on a structure wherein the bistable molecule comprises a main chain and at least one pendant group and wherein at least one photosensitive functional group is attached either to the main chain or to the pendant group, as recited in Applicants' amended Claim 1 (this limitation was previously in Applicants' Claim 7 as originally filed).

No Information Disclosure Statement is being submitted with the citation of this reference, since this reference is being cited for its further elucidation of the bacteriorhodopsin structure and its explanation of the mechanism of switching. Accordingly, no fee associated with an Information Disclosure Statement is deemed necessary.

Nothing in Reed et al, nor in the technical literature relating to bacteriorhodopsin, discloses or suggests Applicants' claimed structure wherein the bistable molecule comprises a main chain and at least one pendant group and wherein at least one photosensitive functional group is

attached either to the main chain or to the pendant group, as recited in Applicants' amended Claim 1 (this limitation was previously in Applicants' Claim 7 as originally filed).

Applicants respectfully request the Examiner to point out where such a disclosure in Reed et al is made of the photosensitive functional group attached either to a main chain or to a pendant group. Applicants submit that in fact, such disclosure does not exist, because the switching is due to a conformational change (cis-trans) and is reversible. In contrast, Applicants' claimed photopatternable bistable molecule employs a distinct photopatternable functional group, either attached to the main chain or to a pendant group. Such a functional group is not met by a disclosure of bacteriorhodopsin, in which the conformational change occurs due to the cis-trans transformation in the main chain itself.

As noted in the previous paragraph, the bacteriorhodopsin is reversibly switchable. This reversible switching is due to incident photons. In direct contrast, however, Applicants' photopatternable molecules are intended to combine switching in the presence of an electric field with photoresist properties for patterning. As stated in paragraph 0018, "Those molecules can serve as both a molecular device and photoresist-type mask for patterning a layer to fabricate molecular circuits." As is well known, a photoresist is irreversibly "switched" once in the presence of photons; there is no reversibility to the process once the photoresist has been irradiated with photons. Likewise, Applicants' molecules are irreversibly switched in the presence of light in order to accomplish the photoresist-like behavior for patterning. Once patterned, the molecules assume their reversible switching in the presence of an electric field.

Summarizing, the bacteriorhodopsin of Reed et al is reversibly switchable in the presence of light; whether bacteriorhodopsin switches in the presence of an electric field is apparently not known and certainly is not disclosed by Reed et al. Applicants' photopatternable molecules are irreversibly switched once in the presence of light and are reversibly switched in the presence of an electric field.

Reconsideration of the rejection of Claims 1, 6, and 8, as amended, under 35 USC 102(e) as being anticipated by Reed et al is respectfully requested.

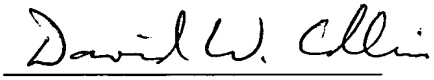
The Examiner indicates that Claims 9-12 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Applicants appreciate that these claims are allowable. Applicants, however, urge that the limitations now recited in Claim 1 (incorporated original Claim 7) render this claim allowable over Reed et al.

Applicants note that, as indicated in the first Office Action (dated December 2, 2003) and Applicants' response thereto (dated December 24, 2003), Claims 12-15 were withdrawn as directed to a non-elected species, with the understanding that upon allowance of a generic claim, these claims would also be allowable. Applicants urge that Claims 13-15 (the Examiner having included Claim 12 in the claims objected to) are also now allowable.

The application, as amended, is considered to be in condition for allowance. The Examiner is respectfully requested to take such action. If the Examiner has any questions, he is invited to contact the undersigned at the below-listed telephone number. HOWEVER, PLEASE CONTINUE TO ADDRESS ALL FURTHER WRITTEN CORRESPONDENCE TO: IP ADMINISTRATION, LEGAL DEPARTMENT, M/S 35, HEWLETT-PACKARD COMPANY, P.O. BOX 272400, FORT COLLINS, CO 80527-2400.

Respectfully submitted,

November 11, 2004



David W. Collins
Reg. No. 26,857
Attorney for Applicants

75 West Calle de las Tiendas
Suite 125B
Green Valley, AZ 85614

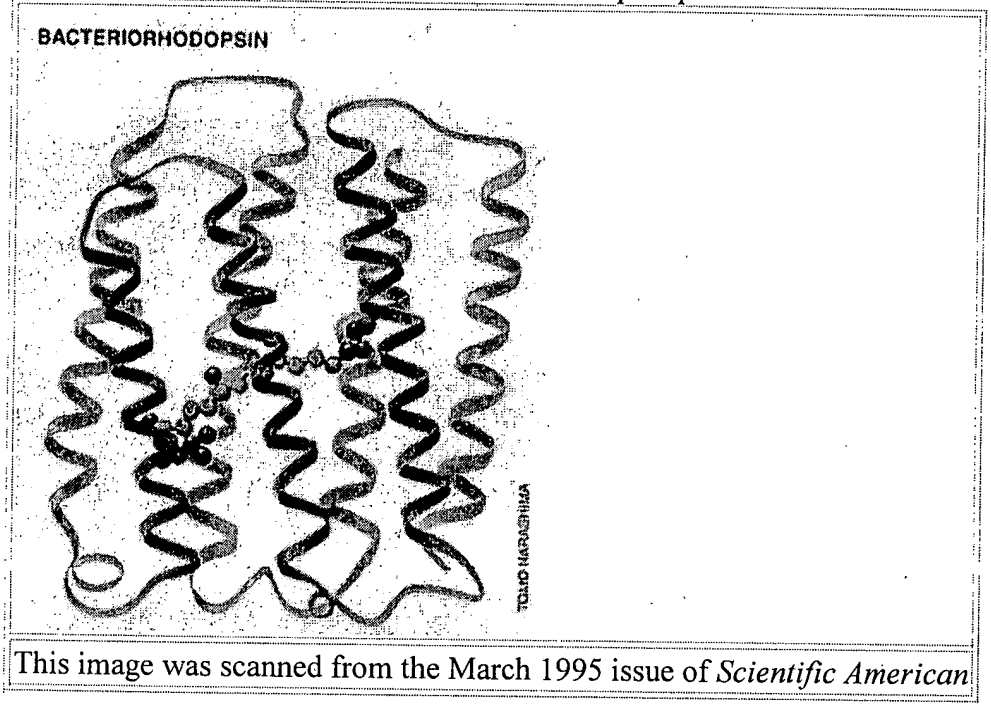
Telephone calls may be made to:
(520) 399-3203

1996 .html

Bacteriorhodopsin Photocycle

Bacteriorhodopsin is a photochemically active protein found in the purple membrane of the bacteria *Halobacterium salinarium*, which was known as *Halobacterium halobium*. The polypeptide chain is made of seven closely spaced alpha-helical segments looped across the lipid bilayer. The interhelical space contains the all-*trans*-retinal chromophore which is linked to lys-216 on helix G as a protonated Schiff base.

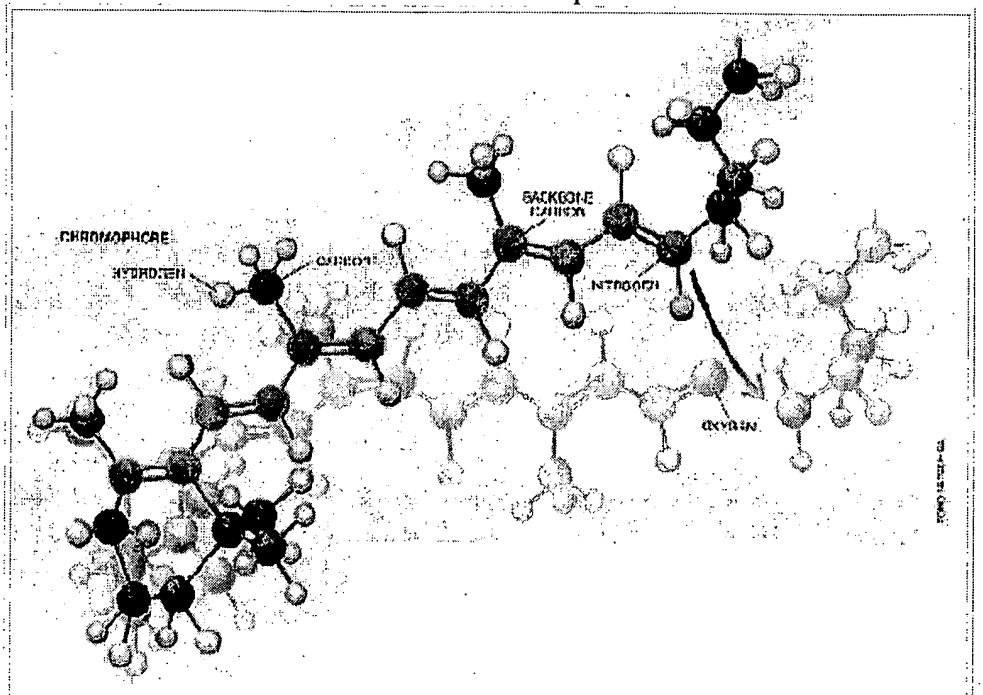
A picture of the bacteriorhodopsin protein



This image was scanned from the March 1995 issue of *Scientific American*

Photochemically active means that it reacts to light. It has a photochemical reaction cycle, or photocycle. This cycle basically transports protons from inside the cell to outside the cell in the bacteria *Halobacterium halobium*. The native photocycle has several spectroscopically unique steps, bR --> K <--> L <--> M1 --> M2 <--> N <-->O, which occur in a roughly linear order. The bR state is the protein in its native state and each intermediate is represented by a letter of the alphabet. However, the important, main photochemical event in this cycle is a trans to cis photoisomerization around the thirteenth Carbon atom to the fourteenth carbon double bond in the chromophore.

This is the chromophore



This image was scanned from the March 1995 issue of *Scientific American*

At around the temperature of 80 K, the native protein undergoes this photocycle and switches between a green absorbing state and a red absorbing state. At approximately room temperature, the protein switches between a green absorbing state and a blue absorbing state. In both the ground (green) and excited (red or blue) states, the chromophore displays several metastable configurations. The main event follows these steps:

1. A change in the shape of the conformational potential energy surface resulting from electron excitation
2. A conformational change
3. A non-radiative decay to the ground state

The single critical step in the proton pumping ability of the protein is the transfer of the Schiff base proton do D85, an piece of the protein, in the L --> M reaction. Absorption of light leads to rapid photoisomerization in the excited state because the barrier to conformation al change in that state is negative. In a manner of thinking, the conformational motion of the excited state acts to gate the conformational motion of the ground state.

In the L state, the Schiff base exhibits strong H-bonding with close water molecules and distorts the chromophore near the Schiff base. The two necesssary coordinators for these water molecules arethe anionic Asp85 and Asp212. That coinceides with the Trp182 interacting with the retinal skeleton by the 9-methyl group. These events bring about the deprotonation of the Schiff base.

Also in the L intermediate state, the backbone has good local structural flexibility. This is evidenced by the many different change in the peptide C to O double bond stretching vibrational frequencies. Some of these frequency variations correlate to the O to H single bond stretching vibrational frequencies. This indicates that the structural changes can come from changing interaction with water molecules. A network of H-bonding including bonds between water and peptides, exists between two

pieces of the protein, Asp85 and Asp96. This network exhibits changes most often in the bR to L transformation, which would be the first step in writing to a block of bacteriorhodopsin memory.

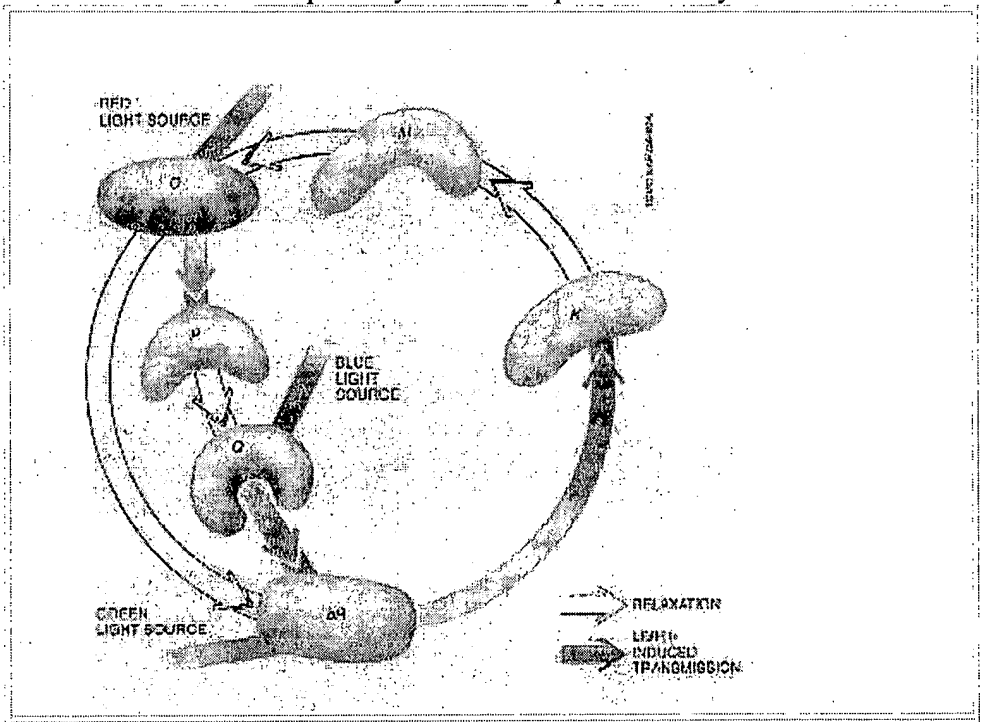
In the K intermediate, a H-bonding change of the peptide C to O double bond of a valine residue, called Val49, occurs. This stays on in the L intermediate, but is gone in the M intermediate. This is affected by a mutation in the protein.

Water appears to affect the C to O double bond affects the protein at specific regions. Some, which exhibit O to H single bond stretching frequencies, interact with the C to O double bond of the Val49 piece.

The relative stability of some of the intermediate states determines their usefulness in computing applications. The initial state of the native protein, often designated bR, is quite stable. Some of the intermediates are stable at about 80K and some are stable at room temperature, lending themselves to different types of RAM.

For computers, the two or three most stable states of the protein would be used to record data in binary form. This is the proposed photocycle for computing needs:

The photocycle for computer memory



This image was scanned from the March 1995 issue of *Scientific American*

An interesting intermediate in the photocycle is the *O* intermediate. The *O* intermediate is an all-trans structure like the native protein state. The native state is a light-adapted state. The *O* state is the red absorbing state.

Information on what mutations could do to the photocycle.

Now that you have read about the mutant, read on:

The M state, or unprotonated Schiff base, does not accumulate in the photocycle. This is strange since this protein transports protons. This could mean two thigs. The first is that the M state cannot be observed bacause the kinetics are set against its build-up. The other is that the Schiff bvase does not deprotonate and the transport is based on a completely different mechanism than the wild type protein. The two kinetic reasons for theis lack of M are that the rate of decay of M is faster than the rate of formation or that the L <--> M and M <--> N equilibria are tilted away from the M state.

References

Proptein Based Computers Birge, Robert R., *Scientific American* March 1995 pp 90 - 95

Molecular and Biomolecular Electronics, Birge, Robert R. Ed., American Chemical Society, Washington D.C. 1994 pp 131-133, 491-510

Brown, Varo, Hatanaka, Sasaki, Kandor, Maeda, Friedman, Sheves, Needleman, Lanyi. **Deprotonation of the Bacteriorhodopsin Schiff Base**, *Biochemistry*, 1995, 34, 12903-12911

Yamazaki, Tuzi, Saito, Kandori, Needleman, Lanyi, Maeda. **Hydrogen bonds of Water and C=O Groups Coordinate Long-Range Structural Changes in the L Photointermediate of Bacteriorhodopsin**, *Biochemistry*, 1996, 35, 4063-4068

Links:

Some animations about bacteriorhodopsin

An article about the photocycle of bacteriorhodopsin.

Back to the home Page